

Space Weather Technical Forecast

From the 24th of September, the way we distribute this forecast is changing and you will need to take action to continue receiving it. You should have received an email on the 4th of September explaining the steps required to do this. If you have already signed up to receive the forecast on our premium website, please disregard this message. If you haven't, or if you need help with the process, please contact moswoc@metoffice.gov.uk

Issued on Wednesday, 11 September 2024 at 00:12 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: G1-G2 storm is likely on Wednesday 11 September. Slight chance of S1 minor radiation storm throughout. Another CME arrival is expected on Friday 13 Sep, with chance of G1-G2, possibly a G3.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity as measured by GOES16 and 18 has been Moderate, with a peak flare of M1.6 at 10/1547 UTC from Ex-3808, which has rotated just beyond the west limb.

There are currently nine sunspot regions on the visible disc, one of which is unnumbered in the southwest quadrant. Most of the active regions are now on the western hemisphere, with most of the regions relatively simple. The largest and most complex region is AR3814, which is near north central meridian. This region consists of a delta spot on the leading portion of its large trailer spot. Immediately east of this region is AR3822, which showed significant growth in the last 24 hours. This region continues to show some minor growth in its trailing spots.

An asymmetric CME was observed on coronagraph imagery during the early UTC hours of 10 Sep, following the long-period M1.2 from AR3814. While the bulk of the ejecta is expected to pass north of Earth, a very faint halo was detected. The analysis revealed an estimated speed of 630 km/s, giving an arrival at Earth early on Day 3 (13 Sep).

Solar Wind / Geomagnetic Activity: The solar wind measured by ACE at L1 showed a possible stepped entry into a fast wind of unknown provenance. The phi angle has been largely negative (towards the Sun), which precludes any contribution from CH65/+. The solar wind speed was slightly elevated, gradually declining to background, ranging between 370-480 km/s. The solar wind density was below average throughout. The IMF was mostly weak, only peaking at 9nT, while the north-south component varied between +8nT and -4nT. The net result of the above solar wind measures was for mostly Quiet geomagnetic activity with two Unsettled intervals.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 showed a gradual decreasing trend, eventually returning below the S1 / Minor Storm level at around 10/0750 UTC, with a peak flux of 29 pfu at midnight on the 10 Sep. High energy electron flux (greater than 2MeV) observed by GOES16 was at mostly background levels. The associated 24-hour fluence remained below the Active threshold, with 1.48e6 integrated pfu observed at 10/2359UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is Likely to continue throughout, with a daily Slight Chance of
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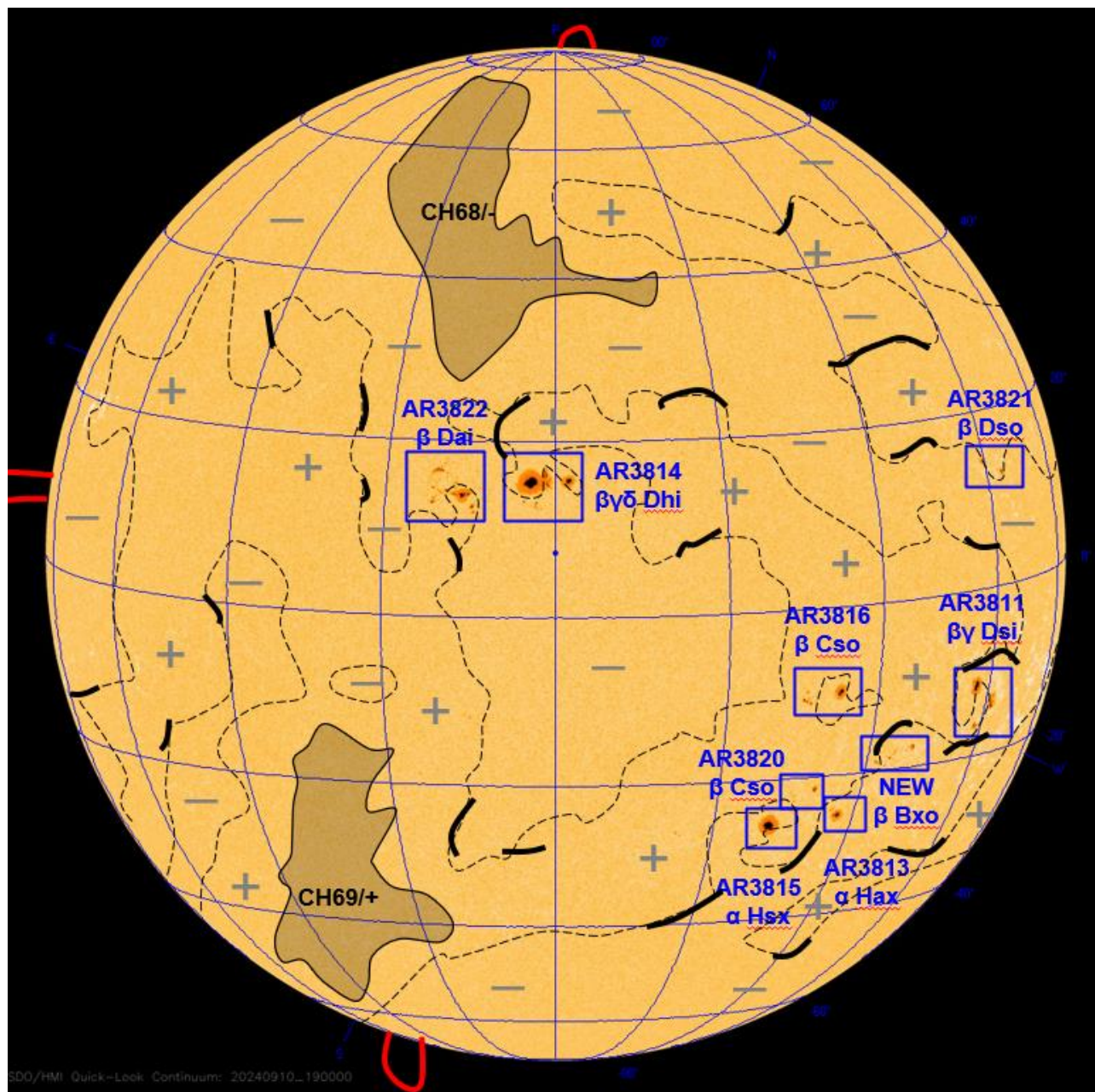
X-class flares. The complexity and flare risk of oncoming sunspot regions is likely to exceed that from any departures through midweek UTC, and the overall risk is upwards around this time.

Solar Wind / Geomagnetic Activity: Two Earth-directed CMEs feature in this forecast. The first one originated from a filament eruption early on 08 September, expected to arrive early day 1 (11 Sep). At the time of writing, it looks like the CME may have arrived at STEREO-A, which is slightly ahead of Earth's orbit. The IMF orientation remains positive (northward) which does not favour significant geomagnetic activity. Still anticipating its arrival at Earth early on day 1 (11 Sep).

The second one followed an M1.2 flare early on 10 Sep, expected to arrive early on day 3 (13 Sep). Enlil is currently offering a reasonable representation of solar wind conditions, and it is felt correct in delaying any fast wind arrival from CH68/- until day 4 (14 Sep).

Energetic Particles / Solar Radiation: A heightened risk of flare activity brings a daily chance of reaching/exceeding the S1 Minor Radiation storm level, should any significant flares occur from active regions in the western hemisphere. High energy electron flux is expected to remain near current Normal Background levels throughout, with Active 24-hour fluence not expected.

Figure 1. Solar Analysis Valid 10/1900 UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There are two potentially Earth-directed CMEs in this forecast.

A partial halo CME associated with a large filament eruption off the northwest quadrant, near Ex-3812, produced a Type II radio emission, with a speed of 924km/s. This has been analysed as potentially giving a glancing blow at Earth early on 11 Sep, although the bulk of the plasma material appears to be going to the west of Earth.

A faint but full halo CME was also observed during the early UTC hours of the 10th, following the long-period M1.2 from AR3814. It also produced a type II radio emission with an estimated speed of 408 km/s. The analysis estimated its speed to be around 630 km/s, giving an arrival at Earth late on 12 Sep or early on 13 Sep. The effects of the CME may linger into the start of the UTC weekend.

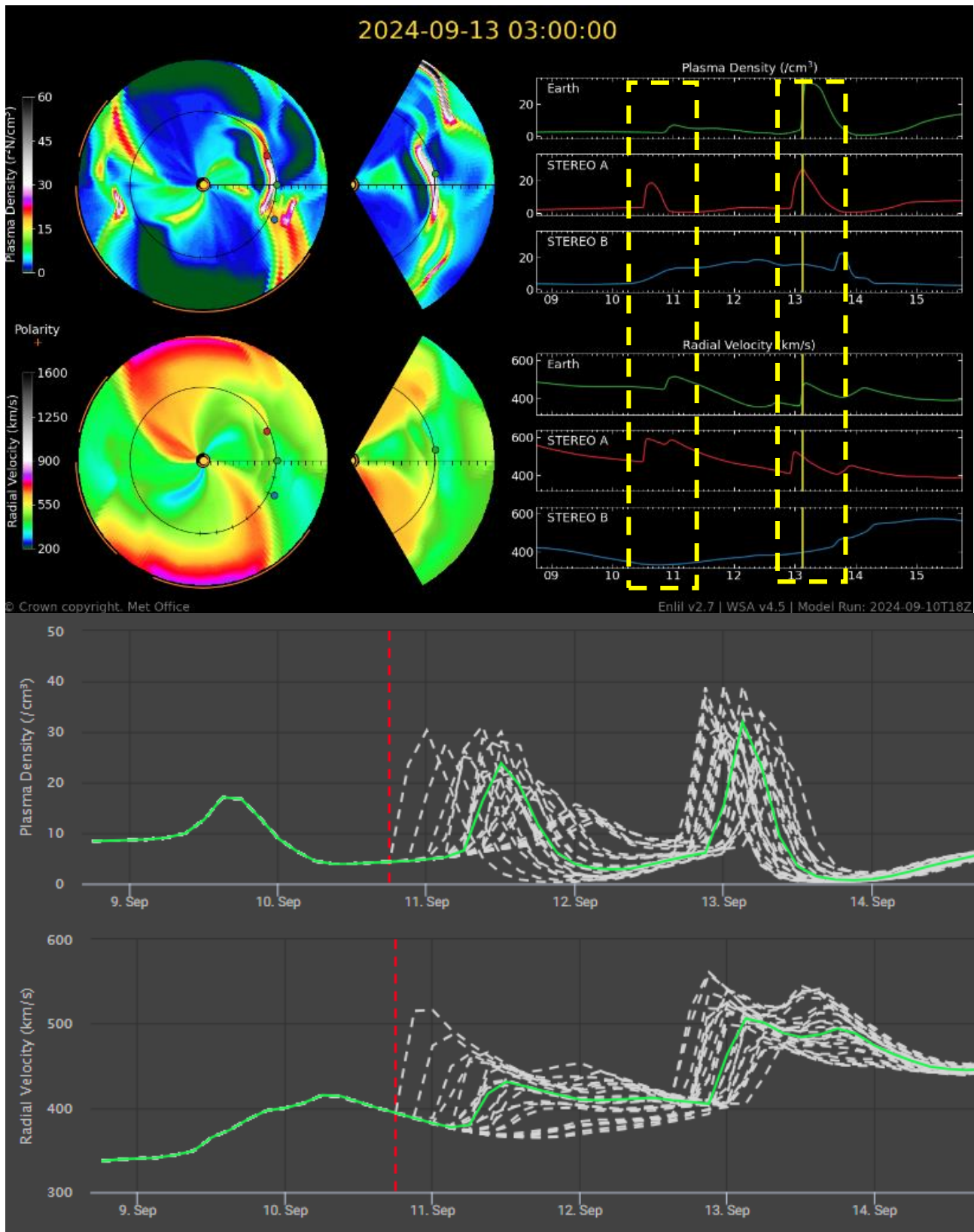
On balance, there is a chance of G1-G2/Minor-Moderate Storm on day 1 (11 Sep). Some Quiet to Unsettled conditions on Day 2 (12 Sep) but an increasing risk of further G1-G2/Minor-Moderate Storm intervals early on Day 3 (13 Sep), with a slight chance of G3 / Strong Storm interval. The CME impacts probably lingering into Day 4 (14 Sep).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	40	10	60	20
Strong	G3	No	10	1	20	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
08/0525 UTC	Partial	Filament	NW	700 km/s	11/0000 UTC +/- 12 hours	Glancing blow likely
10/0526 UTC	Faint full halo	AR3814	NE	630 km/s	13/0300 +/- 9 hours	Mostly passing N, but possible direct hit.

Figure 2: MOSWOC Enlil and Ensemble shows likely arrival times of two CMEs that feature in the forecast. 1) Glancing blow CME likely on 11 Sep. 2) Full halo CME expected to arrive 13 Sep.



Radio Blackouts - X-Ray Flares:

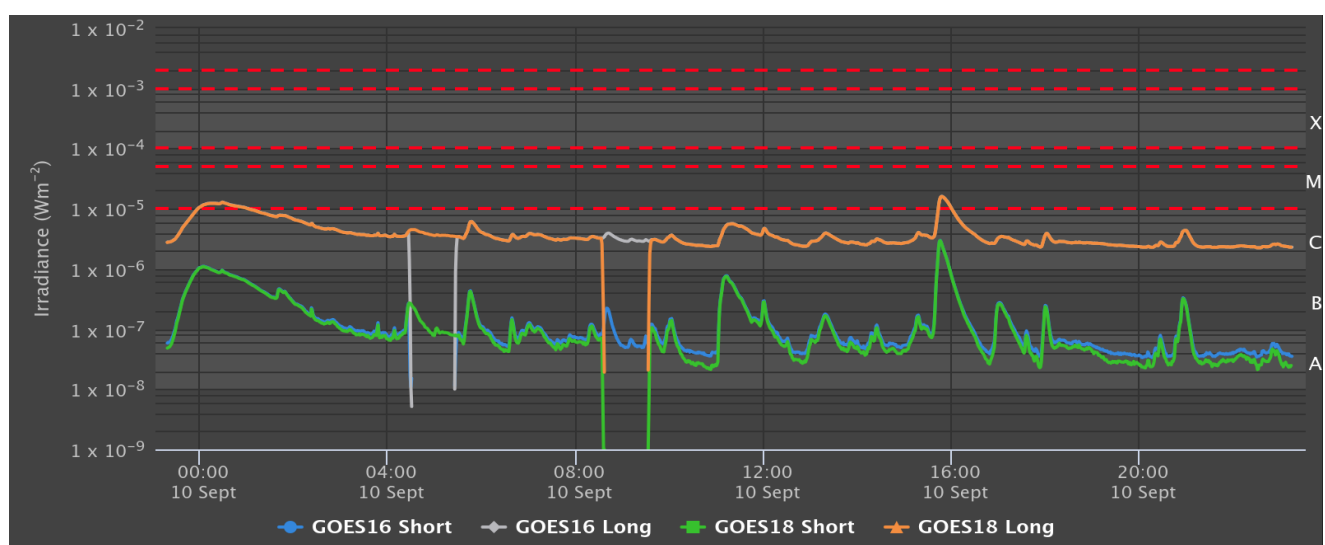
There are currently nine sunspot regions on the visible disc, one of which is unnumbered in the southwest quadrant. Most of the active regions are now on the western hemisphere, with most of the regions relatively simple. The largest and most complex region is AR3814, which is near north central meridian. This region consists of a delta spot on the leading portion of its large trailer spot. Immediately east of this region is AR3822, which showed significant growth in the last 24 hours. This region continues to show some minor growth in its trailing spots.

The imminently arriving eastern solar horizon encompasses several large returning regions including Ex-AR3790, 92, 93 and 3802, i.e. those roughly between Carrington Longitudes 020 and 035. One of the northern hemisphere regions, perhaps 3802 was responsible for a large and energetic CME in the past 24 hours off the eastern limb, and was perhaps also responsible for noteworthy far-sided CMEs on 03 and 05 September. As well as this northern hemisphere feature, there appears to be a magnetic connection to the southern hemisphere cluster (for example, AIA171 imagery), and this part of the Sun returning to the facing side of the disc is therefore very likely to result in an upturn in daily flare risk.

With Ex-AR3806 rotating off the disc, there are no more departures expected until AR3811 and AR3821 follow suit by day 3, Friday 13 September. Given the likely complex arrivals due by midweek UTC, the overall risk of significant flares is upwards in the period, with M class Likely and a Slight Chance of X-class.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	60	70	70
Very Active	R3 to R5 X Class	No	10	10	15	15

Figure 3: GOES16/18 X-Ray flux trace



Solar Radiation Storms - (High Energy Protons):

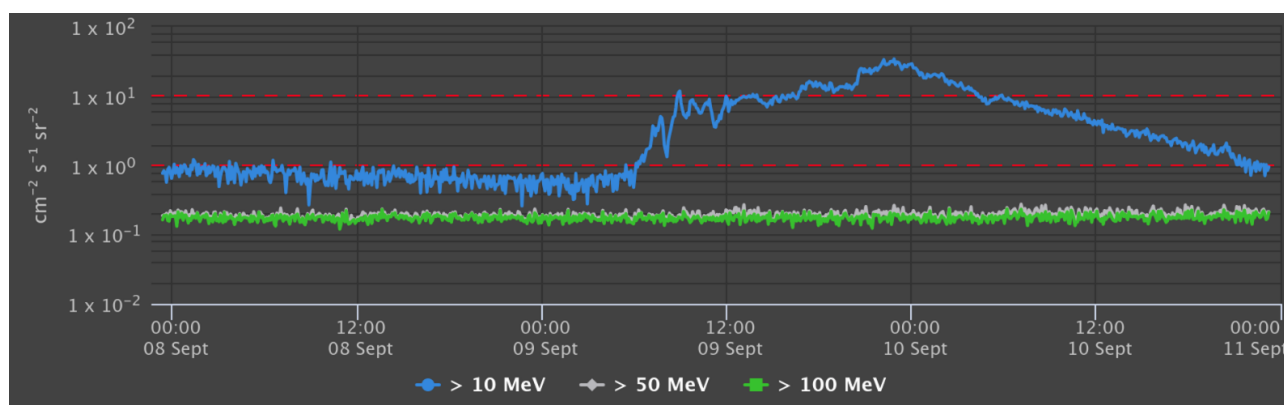
High energy proton flux showed a gradual decreasing trend, eventually returning below the S1 / Minor Storm level around 10/0750 UTC after the enhancement prompted by the long-period 09/0333UTC M1.0 from Ex-3808. The flux is currently levelling off just below the S1 level and is expected to remain at this level over the next 24 hours.

Further chance of reaching the S1 Minor Radiation Storm threshold in the coming days, if any other significant flaring occurs from the cluster of active regions currently transiting across the southwest quadrant.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	Yes	20	20	20	20
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

Figure 4: GOES-18 Proton flux – shows an S1 minor radiation storm occurred on 09 Sep, but has since declined below the S1 threshold. Slight chance of further S1 events are forecast.



High Energy Electrons Event ($\geq 2\text{MeV}$):

The diurnal oscillation of high energy electron flux has been within the confines of Normal Background levels in the past 24 hours. While Earth may now have connected with a minor fast wind, the fact that this appears to have now peaked should mean there is little likelihood of Active 24-hour fluence resulting, especially since the 08 September CME is perhaps due at a time when any recovery of the Van Allen belts to encompass GEO might be expected.

All considered, the chances of Active 24-hour fluence are very low throughout.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	1	1
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: Latest MOSWOC REFM output.

